Refining Bedrock-Topography and Drift-ThicknessMaps in Ohio

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Abstract

The Ohio Department of Natural Resources, Division of Geological Survey is improving existing bedrock-topography and drift-thickness raster maps in Ohio. The existing statewide bedrock-topography and drift-thickness raster maps were created in 2003 (Ohio Division of Geological Survey, 2003a) and 2004 (Powers and Swinford, 2004), respectively, and have a 60-meter resolution. The bedrock-topography raster data set was created by compiling the 1:24,000-scale bedrock-topography contour lines into a grid surface. The results were clipped at generalized glacial boundaries and represent only the elevation of bedrock that is buried beneath glacial and alluvial deposits. Areas that have no data are assumed to have bedrock at the surface. The drift-thickness dataset of Ohio depicts the thickness and distribution of glacially derived sediments (called *drift*) and post-glacial stream sediments overlying the buried bedrock surface. The drift-thickness map was produced by subtracting bedrock-surface elevations from land-surface elevations to produce a residual map of drift thickness. Unfortunately, these existing maps contain errors in which some areas of the bedrock-topography elevation is higher than the topographic elevation. Also, since the bedrock-topography map was clipped to a generalized glacial boundary, some areas along the glacial margin that were mapped as containing drift are actually bedrock. In addition, in areas along the glacial margin where the mapped bedrock topography terminates, the bedrock topography elevation does not match the topographic elevation. Modern data from water well records, digital soil maps, passive seismic data, and higher-resolution digital elevation models are being used to correct errors and produce higher-resolution maps.

Introduction

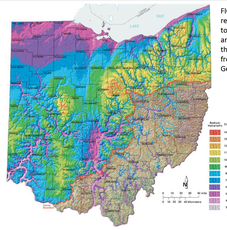

FIGURE 1: Existing 60-meter resolution bedrock-topography raster, contains areas where bedrock is above the land surface. Modified from Ohio Division of Geological Survey (2003b).

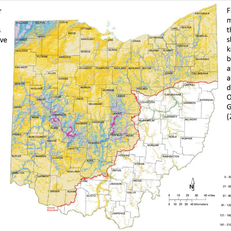

FIGURE 2: Existing 60-meter resolution drift-thickness raster, showing areas known to have bedrock at the surface as having large amounts of overlying drift. Modified from Ohio Division of Geological Survey (2004).

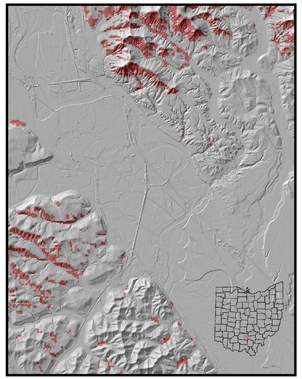

FIGURE 3: Areas in red indicate where the existing bedrock-topography elevation is above the land surface (i.e., negative drift thickness). Extent indicates the Chillicothe East Quadrangle, which serves as an example for the procedures presented.

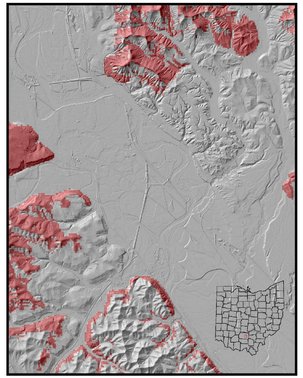

FIGURE 4: Areas in red indicate where the existing drift-thickness raster shows drift, although bedrock is known to be at the surface.

Defining a Mask

In areas near the glacial margins and areas of thin drift, a polygon mask (figs.5 & 6) is created based on an interpretation of the surficial geology, geomorphology, and soil parent material of the region. The polygon mask constrains the extent of the interpolation used to create the new bedrock-topography raster. The polygon mask also is used to create initial control points (fig. 5) by using the *Vertices to Points* tool. These control points are then assigned an elevation from the DEM using the *Extract Values to Points* tool.

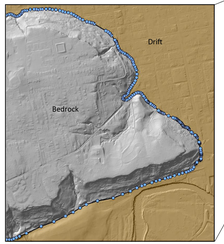

FIGURE 5: Control points (blue) created from vertices of the mask.

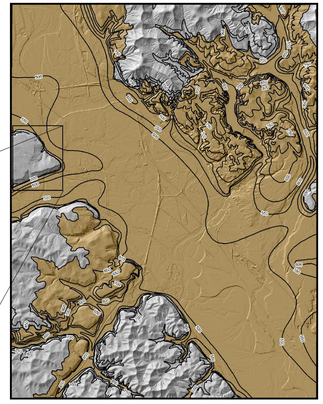

FIGURE 6: Tan area shows the extent of the polygon mask and delineates where the bedrock topography will be interpolated. Black lines are existing bedrock-topography contours (CI = 50 feet)

Adjusting Contours

The bedrock-topography contours are adjusted based on water well records, higher-resolution DEMs, and passive seismic data (fig. 7 & 8). These data are the core of what will be used in the interpolation. Therefore, every effort is taken to ensure contours do not rise above the surface DEM. Additional care is taken to match bedrock-topography contours to surface contours at the edge of the polygon mask (fig. 7).

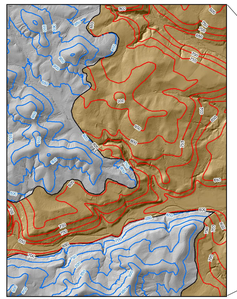

FIGURE 7: Surface contours (blue) meeting bedrock-topography contours (red) at the polygon mask boundary (black).

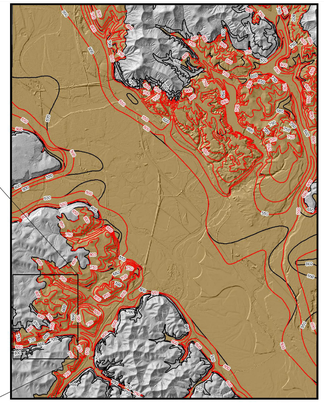

FIGURE 8: Black lines are existing bedrock-topography contours. Red lines are adjusted bedrock-topography contours to be used in the interpolation.

Running Interpolation Model

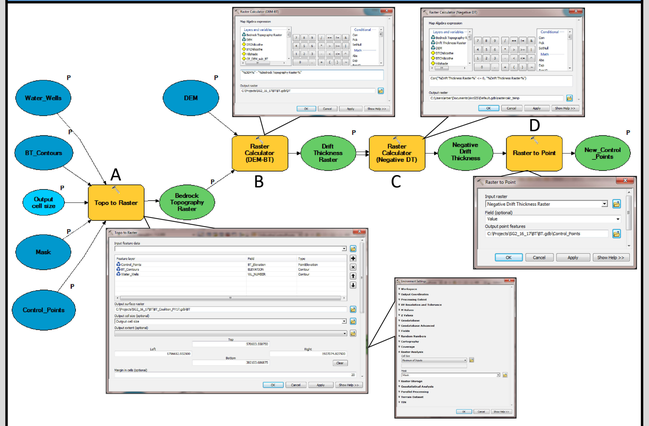

FIGURE 9: Model used to interpolate and produce a bedrock-topography raster, drift-thickness raster, negative drift-thickness raster, and a control-point feature class. (A) The model first runs the *Topo to Raster* tool to create a bedrock-topography raster. (B) Next, *Raster Calculator* creates a drift-thickness raster by subtracting the bedrock-topography raster from the input surface digital elevation model. (C) Then, a second *Raster Calculator* tool exports all of the negative drift-thickness values from the drift-thickness raster into a new negative drift-thickness raster. (D) Finally, the *Raster to Point* tool creates a control point in each cell created in the negative drift-thickness raster.

Addressing Problem Areas

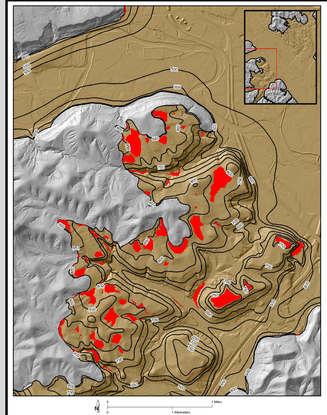

FIGURE 10: Negative drift-thickness output from model (red) shows locations where drift-thickness is negative. The model also helps identify areas that may need additional depth-to-bedrock data points, which can be collected using a passive seismic device.

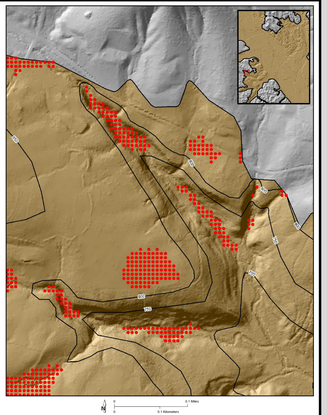

FIGURE 11: Control point generated from model (red points) at locations where drift-thickness is negative (i.e., bedrock above the surface DEM). Control points are assigned elevations manually based on surrounding data. Negative-drift thicknesses generally occur along the edge of the polygon mask or in narrow valleys.

Finished Map Products

Bedrock Topography of the Chillicothe East Quadrangle, Ohio

Drift Thickness of the Chillicothe East Quadrangle, Ohio

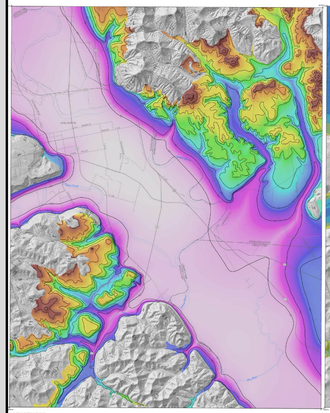

FIGURE 12: Revised bedrock-topography map of the Chillicothe East quadrangle. Bedrock is at or below the land surface and contours are continuous over the polygon mask boundary.

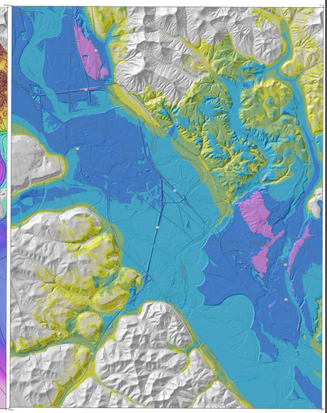

FIGURE 13: Revised drift thickness map of the Chillicothe East quadrangle. Excessive drift-thicknesses no longer occur in areas where bedrock is present at the surface.

Conclusions and Future Work

The modifications being made to the existing bedrock-topography and drift-thickness maps in Ohio are correcting errors and improving the quality and resolution of the maps. Bedrock surfaces depicted in the bedrock-topography raster no longer rise above the land surface and the raster resolution is much improved from a 60-meter to a 2.5-foot grid. By removing drift where bedrock is present at the surface, drift-thickness maps better reflect surficial geology and bedrock topography. The model is key to the consistent implementation of bedrock-topography mapping procedures. As mapping areas change from year to year the model allows mappers to produce bedrock-topography maps with the same level of detail. The model also allows users to view problem areas and address them quickly and specifically according to the surrounding data. Passive seismic data are a great benefit in adding depth-to-bedrock information to areas with sparse data coverage. Techniques presented here currently are being used in select areas of detailed surficial mapping in Ohio. In the future, bedrock topography will be refined for 7.5-minute quadrangles in conjunction with detailed surficial mapping projects.

References

Ohio Division of Geological Survey, 2003a, Bedrock-topography data for Ohio: Ohio Department of Natural Resources, Division of Geological Survey Digital Map Series BG-3, 1 CD-ROM, GIS file format.

Ohio Division of Geological Survey, 2003b, Shaded bedrock-topography map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map BG-3, generalized page-size version with text, 2 p., scale 1:2,000,000.

Ohio Division of Geological Survey, 2004, Shaded drift-thickness map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map SG-3, generalized page-size version with text, 3 p., scale 1:2,000,000.

Powers, D.M., and Swinford, E.M., 2004, Shaded drift-thickness of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map SG-3, scale 1:500,000.